CHAPTER 6

NUCLEAR WEAPONS FIREFIGHTING PROCEDURES

Section I. GENERAL

6-1. Purpose and Objective

This chapter provides guidance to all individuals concerned with fires involving nuclear weapons and associated high explosives.

6-2. Policy

It is Department of the Army policy that fires in an area containing nuclear weapons will be fought until an explosion is imminent.

Section II. RESPONSIBILITIES

6-3. Introduction

The prevention of accidents, including fires, is a responsibility of command. Commanders at every echelon are responsible for prevention of accidents involving personnel, operations, and activities under their jurisdiction. General areas of responsibilities, and policies and procedures to be followed for prompt, effective, and coordinated response to accidents and/or incidents involving nuclear weapons, are set forth in AR 50-2.

6-4. Commanders

Commanders responsible for the storage, handling, or transportation of nuclear weapons or nuclear materials will insure that

a. Personnel involved in the transportation, storage, or handling of nuclear weapons are familiar with the provisions of applicable nuclear accident information plans prepared in compliance with Department of the Army, USCONARC, and major oversea basic policies, with particular reference to guidance governing the release of information to the public regarding the presence of nuclear weapons or material at an accident scene.

b. Personnel working inthe vicinity of nuclear weapons are informed of and trained in proper fire-protection procedures.

c. Standing operating procedures are published and enforced, as required, concerning such matters as control and mvoement of nuclear weapons, positioning of firefighting equipment, exposure control and evacuation of personnel in case of fire, reporting procedures required, and the like.

d. Civilian fire departments (municipal) which may be called upon to assist in extinguishing fires involving nuclear weapons are informed of the hazards involved and the procedures to be used,

6-5. Couriers

Nuclear weapons are classified items of material and as such must be safeguarded at all times.

a. Couriers are military personnel physically accompanying shipments of nuclear weapons material for security purposes. In effect, the courier "owns" the material; i.e., he is the direct custodian of it. While he is physically able, it is the courier's responsibility to protect the material from loss or security compromise.

b. At the time of departure each courier is furnished information as to organizations which are to be contacted in event of an accident or incident. Couriers are capable of rendering technical advice pending the arrival of specially trained personnel.

6-6. Decontamination and Disposal Teams

a. Specially trained teams of personnel responsible for and equipped to detect radiation, to neutralize a weapon if necessary, and to decontaminate the area of explosives or nuclear materials, are maintained by the military services and by the Atomic Energy Commission.

b. Immediately upon notice to the military and

Atomic Energy Commission of an accident involving nuclear weapons, one or more of these teams, known as "Nuclear Emergency Teams," "Explosive Ordnance Disposal (EOD) Detachments," "Radiological 'Contamination (RADCON) Teams," "Alpha Teams" and "Radiological Emergency Medical Teams (REMT)", will be dispatched to the accident area.

6-7. The Nuclear Weapon—General Safety Factors

The extreme care devoted to the design of nuclear weapons and the equipment and procedures for handling them has been repaid with a record of no inadvertent or unintentional nuclear detonations. Because of the volume of weapons handled daily, accidents cannot be ruled out entirely. Because of the safety factors designed into the weapons, accidental detonation of the nuclear material is virtually impossible.

6-8. Explosion

In a typical nuclear weapon, high explosives surround the mass of nuclear material. The simultaneous explosion of the high explosives, timed in millionths of seconds, exerts even pressure inward on the subcritical mass of nuclear material and compresses it until it becomes supercritical, fissions, and sustains a chain reaction.

a. To become critical, the mass of nuclear material requires even compression by the surrounding high explosive. There can be no chain reaction until enough pressure is applied uniformly to sustain chain reaction.

b. To insure that the high explosive sends its pressure uniformly to all areas of the nuclear mass, a typical weapon has detonators arranged at many points, to be set off simultaneously by an electric charge, If the high explosive becomes accidentally ignited by fire at one point, it will burn or perhaps explode, but it will neither burn nor explode with sufficiently uniform pressure to make the mass critical. If the weapon should be inadvertently dropped, struck, or should accidentally fall from an aircraft, the blow may cause the ignition or explosion of the high explosive. Again, while any explosion would be at the one point which receives the blow or shock, this will not cause the nuclear material to become critical and sustain chain reaction.

6-9. Hazards

a. ***General.*** Even though nuclear weapons are so designed as to prevent a nuclear yield in the event of accidental detonation, there is still a potential hazard commensurate with conventional weapons and materials. 'The two components of a nuclear weapon which constitute the most probable hazard in case of an accident are—(1) the high explosive ; and (2) the nuclear material. Other components may produce hazards, but they are of such nature that precautions taken against high explosive and nuclear materials are more than enough for their control. It should be kept in mind that accidents involving nuclear weapons or components usually will involve other materials in more widespread use, such as gasoline or other volatile and explosive fuels.

b. High Explosives. Most nuclear weapons contain high explosive. This high explosive compreises the major hazard associated with accidents involving nuclear weapons.

(1) *Identification.* Burning high explosives have certain characteristics which will enable the firefighters to recognize them. The high temperature at which they oxidize causes hot flame, or "torching," which is easily distinguishable from the flame of, for instance, burning petroleum fuels, or other materials. The smoke of burning explosive from nuclear weapons is noticeably light in color as it mingles with that from most other burning fuels.

(2) ***Characteristic hazards.*** As they burn, high explosives melt, flow, drip, spread, and mix with surrounding ground or wreckage. After the fire is extinguished these explosives are safe only if they are completely burned. ***High explosives which have not completely burned remain an extreme explosive hazard.*** After these explosives have cooled below ignition temperature they will, like metal, take on curious shapes. They may have picked up impurities, while molten or burning, which will make them actually more dangerous than they were before melting.

c. ***Detonation.*** In any accident involving a high explosive there is the possibility of a detonation occurring. The detonation may range from a very small one to one of considerable magnitude; or it may be a series of small explosions. The breakup of the weapon from impact or a small explosion will probably result in the local scattering of small pieces of high explosive. Rough handling, as well as accidents, may produce powdered explosives. Most high explosives are more sensitive in these conditions and are more apt to detonate when subjected to heat or impact or friction.

6-10. Nuclear Yield

The possibility of the accidental nuclear detonation of a nuclear weapon is so remote as to be negligible.

6-11. Nuclear Materials

a. *General.* As the result of impact or detonation of the high explosive, nuclear materials become dispersed as finely divided particles or, if a fire occurs, become dispersed as oxides. These particles, or oxides, are alpha emitters. Unlike the beta and gamma radiation in the fallout of a nuclear explosion, alpha radiation has a very short range and lacks the ability to pierce the skin.

b. *Body Effects.* Because of the inability of the alpha radiation to penetrate the skin, nuclear materials are not a hazard if they remain outside the body,,

(1) To avoid possible radiation effects and also the possibility of heavy-metals <poisoning (similar to lead poisoning), effort should be made to prevent nuclear material from entering the body.,

(2) When finely divided particles of nuclear materials, or their oxides, are suspended in the air, it is possible to swallow them or inhale them. Cuts in the skin provide another and more dangerous source of entry into the bloodstream.

c. *Intake.* Field experiments indicate that the principal source of intake of nuclear materials into the body is inhalation during the passage of the cloud resulting from the detonation or the burning of the nuclear material. Once the fine particles have been deposited on the ground, the hazard is markedly reduced. However, care should be taken that dust, which may have been contaminated, is not stirred up.

(1) It is always desirable to reduce to a minimum the intake of nuclear materials but, when necessary, one may enter or remain in a highly contaminated open area for short periods (up to several hours) after passage of the smoke cloud.

(2) Respirators, or preferably self-contained breathing <apparatus, and protective clothing should be worn.

(3) Persons with cuts should remain outside the contaminated area(s).

(4) Under extreme emergency conditions, and in the absence of respirators or self-contained breathing apparatus, a wet handkerchief over the nose and mouth may be utilized to reduce the intake of nuclear material into the body.

6-12. Fire

If a nuclear weapon is enveloped in flame the high explosive may ignite, burn, and in many cases detonate. ***Whenever heated or burning high explosives*** are ***confined, as in an intact weapon, detonation may occur at any time.*** High explosives which have not completely burned may actually be more sensitive and dangerous than before being subjected to fire (para 6-9).

6-13. Fire Symbols: Explosive Symbols

a. General. To provide guidance to firefighting forces it is an accepted practice to divide explosives into four groups in accordance with the general burning and explosive characteristics of the materials and the relative danger in fighting fires in which they are present. The four groups are identified by symbol numbers 1 through 4. The hazard to firefighters increases progressively with the numbers. Nuclear weapons containing high explosives are included in the symbol 4 group (*b* below). However, it must be understood that the fire symbols were developed for conventional ammunition long before nuclear weapons came into being. Where nuclear weapons are concerned, categorizing the weapons on the same basis with conventional ammunition without due consideration of all the aspects of design, packaging sensitivity, and without regard for weapon vulnerability, would result in an unacceptable abandonment of the weapon to a fate where, in most instances, timely and intelligent application of firefighting techniques would and could prevent disaster. With conventional ammunition, a fire may involve various types of ammunition and explosives, each type varying in sensitivity and vulnerability to heat and flame. Packaging in most cases is highly flammable, thereby increasing the danger and rendering the firefighting effort more difficult.

b. Symbol 4. This includes materials which may detonate when involved in a fire. The safety of personnel in fighting a symbol 4 fire depends on the accuracy of the informatoin made available to the firefighting forces. In case of rail or vehicle fires outside of the military installation, the transport vehicle will be labeled with *"explosive"* placards. All such vehicles with "explosive" placards will be regarded as symbol 4. For nuclear weapons involved in a fire, the minimum area to be cleared is 2000 feet (610 meters) (para 6-16*b*) in all directions of the fire.

Section III. GENERAL FIREFIGHTING GUIDELINES

6-14. Planning Prior to a Fire

The potential hazards surrounding a fire involving a nuclear weapon, and the protective measures which can be taken, vary widely. The time, during which a fire can be fought before detonation of the high explosive component becomes a possibility, will be critical in some cases. Therefore, it is important that situations in which a weapon may become involved in a fire be anticipated to the maximum extent feasible. Written plasn of action or standing operating procedures should be prepared and should be familiar to all personnel who may become involved.

6-15. Emergency Procedures

The first observer of the fire should—

a. *Assist.* Give immediate assistance to personnel where possible. However, except for the saving of lives, keep away from the fire. There is always the danger of a detonation of the high explosive component. Remain upwind and uphill from the fire. In saving lives, use any available method to prevent smoke from entering your eyes, nose, and throat.

b. *Report.* Report the fire immediately to the nearest fire department, whether military or municipal. Upon arrival at the scene, the police or fire department (military or municipal) should be asked to notify the nearest military installation or Atomic Energy Commission office (para 6-6).

6-16. General Procedures

The techniques for fighting fires in which nuclear weapons are involved are basically the same as those used in fighting fires involving high explosives. The critical factor is the brief time available to extinguish or control the fire before the nuclear weapon is enveloped in flame. Therefore, teamwork and the quick application of current firefighting and operational procedures are vital to the successful fighting of such fires.

a. *Determination.* The primary consideration in determining whether to fight the fire is "How soon will an explosion occur ?"

b. Clearing the Area. One of the first actions in any fire involving nuclear weapons is to clear the area of all personnel not actually needed or engaged in the firefighting operation. Where nuclear weapons are involved, the minimum clearance distance is 2000 feet (610 meters). Even at this distance injury from flying objects is possible.

c. Time Factor. If the fire or impact does not immediately detonate the high explosive, the period of time available to fight the fire before such detonation might occur varies from a few minutes to an indefinite period, depending on the physical characteristics of the weapon casing and the intensity and proximity of the fire.

(1) When the weapon is enveloped in flame, or is subjected to high heat from conduction, convection, or radiant heat energy, the time factor is critical.

(2) When burning high explosives are confined, as in an intact weapon, *detonation of the high explosives may occur at any time.*

(3) When an intact weapon has become so heated that it cannot be touched with the bare hand it is vulnerable to detonation of the high explosive component.

(4) When an explosion is imminent all personnel will be cleared to at least 2000 feet (610 meters) from the fire. Personnel will not attempt to fight the fire.

(5) If the weapon is in an area adjacent to a fire but is not enveloped in flames, personnel should attempt to cool the weapon while extinguishing the fire.

d. Safety Measures. The standard firemen's bunking clothing, boots, and helmet provide adequate shielding against the alpha radiation which may be present. Self-contained breathing apparatus and tight-fitting goggles should be worn if at all possible. The fact that some or all of these items are not available should not hold up operations necessary for rescue of personnel.

e. *Attacking The Fire.* If the decision is made to attack the fire, the senior fire department officer must make decisions rapidly. (If the available supply of water and other extinguishing agents is adequate, it may be possible to cool the weapon with a water fog and extinguish the main fire at the same time. If the water supply is such that both cooling and extinguishing operations cannot be accomplished, and it appears that this fire can be extinguished or controlled to a point at which heat absorbed by the weapon will not exceed safe limitations, it may be advantageous to use all available water on the fire itself.)

(1) Approach the fire from upwind and at a

maximum angle to any armament that might be involved. (For instance, since the heat of flames might fire them, do not approach directly into the line of guns, rockets, or missiles in the nose, tail or wings of a wrecked aircraft.) The approach should afford maximum effective application of extinguishing agents on the critical area and permit rapid withdrawal of men and equipment.

(2) The most important thing is to cool the high explosive and to secure control of fuel or other exposing fires quickly. If a weapon is located, cool its entire surface with the available extinguishing agent.

(3) Water is the most effective agent for cooling a weapon, or for extinguishing a fire involving high explosives. Application as a fog or spray is desirable. High pressure application can be dangerous; it can scatter exposed explosives, such as may be encountered with a damaged weapon.

(4) Foam in a wet mix may effectively be used to extinguish fires in explosives. Its disadvantage for this use is that it is not as good a cooling agent as water and it conceals the extinguished but still dangerous residue. This concealment increases the probability that the sensitive explosive will be stepped upon, and increases the difficulty of cleanup after the fire. The insulating quality of foam may be used effectively to shield a cool weapon from flame or heat. Because of its insulating quality, and reduced cooling effect, ***foam., especially the protean type, will not be applied to a hot weapon if other agents*** are *available.*

(5) High explosive materials have all the oxygen necessary for combustion included in their chemical composition. Therefore, dry powder, carbon dioxide (CO_2), or other agents which extinguish fires by smothering or displacement of oxygen, are not effective in extinguishing fires in explosives. These extinguishing agents can, however, be used to gain control of fuel fires which, if permitted to continue burning, would involve the weapon.

(6) After initiation of firefighting, if evacuation of firefighting personnel is required, they will be withdrawn immediately upon order of the senior fire department officer. If possible, equipment will also be withdrawn. The minimum evacuation distance will be 1200 feet (366 meters) for firefighters and related support personnel.

f. Action After Fire Extinguishment.

(1) Immediately upon extinguishment of the fire all personnel will be withdrawn a minimum distance of 2000 feet (610 meters). The area in which the weapon is located will be kept clear of all personnel, other than the specially trained disposal and decontamination teams, until it is designated safe by the agency having such responsibility.

(2) When the fire is extinguished, personnel and all equipment that may have become contaminated from the smoke of a burning atomic weapon, will be congregated and isolated in an area at least 2000 feet (610 meters) from the weapon. This isolation is necessary to prevent possible contamination of others and will be maintained until release is authorized by specially trained and equipped monitoring and decontamination personnel.

Section IV. FIRES INVOLVING NUCLEAR WEAPONS

6-17. Storage Fires

a. General. Weapon storage facilities will vary with geographical areas. Normally, storage of weapons will be in one of the following:

(1) Underground magazine.

(2) Earth-covered igloo magazine.

(3) Outdoor storage.

(4) Rudimentary storage.

b. Fire Potentials. Weapon storage locations are restricted in the use of flammable materials and flame-producing devices. Because of these restrictions and the high order of supervision and care required, fires seldom occur in weapon storage facilities. However, certain fire potentials may be present and should be considered, eliminated, or controlled. These potentials include building electrical systems ; fork lift trucks (electrical system, hydraulic system, or brake drums (overheated)); storage hydraulic system (elevators) ; grass or woodland.

c. ***Procedures.*** When a fire occurs in a weapon storage location-

(1) Send someone to notify the fire department and other personnel as soon as possible.

(2) Apply portable firefighting equipment immediately, while the fire is in the incipient state, to extinguish the fire or control its spread.

(3) Remove power from electric circuits ; if and when indicated, remove fork lift trucks, and the like, to a safe area.

(4) Remove all weapons from the storage location to a safe distance from the fire when possible.

(5) Techniques and procedures used by the fire department upon its arrival will be in consonance with paragraphs 6-15 and 6-16.

6-18. **Rail Fiires**

Rail shipment fires may occur at any point in the routing of the shipment: along the railroad, at railheads, at interchanges, or on a spur of the shipping or receiving installation. Procedures for dealing with rail fires require a rapid analysis of the situation. The following procedure will be taken :

a. Send someone to secure aid from motorized fire departments, if possible.

b. Immediately apply protable firefighting equipment.

c. Isolate the affected car from other cars.

d. Immediately inspect the interior of the car to see if the fire has penetrated inside and possibly ignited areas within the car.

e. If the fire or sparks have penetrated the floor or side of the car and the weapon is not enveloped in flame, fight the fire with any available firefighting equipment (water is preferable except for flammable liquid fires where foam is indicated).

f. Where size of the items, and conditions permit, remove the lading.

g. When an explosion is imminent, evacuate all personnel as provided in paragraph 6-16*e* (6) and 6-16*f*.

6-19. **Transport Vehicle Fires**

a. *General.* Fires in transport vehicles may result from various causes. The most common causes of vehicle fires are electrical short circuits; collisions ; overheated brakes ; overheated tires ; improper fueling techniques ; broken fuel lines ; careless smoking habits; and the like.

b. Plan of Action. Because of the varied situations or locations in which a transport vehicle may be involved in a fire, it is essential that the courier and transport driver have a mutually understood plan of action.

c. *Procedures and Techniques.* The following will be considered in developing a plan of action for transport vehicle fires—

(1) Every effort must be made to prevent the detonation of the high explosive component of the weapon.

(2) Procedures and techniques (para 6-15 and 6-16) may involve separation of a burning tractor from the van containing the weapon, the use of portable fire-extinguishing equipment pending arrival of the motorized fire department, and the unloading of the weapon from the vehicle.

(3) In some instances, such as a fire involving substantial spillage of flammable liquids or one involving liquefied petroleum fuels, and under other circumstances, it may be evident that there is no way of keeping the weapon cool enough to avoid detonation of the high explosive component. In such cases, the utmost effort must be directed toward the evacuation of all personnel from the area. On the open highway, immediate action will be taken to establish roadblocks at a safe distance. Minimum distance is 2000 feet (610 meters) ; preferably no less than three-fourths of a mile (1.2 kilometers).

6-20. Tactical Vehicle Fires

a. *General.* Tactical vehicles tranpsorting weapons will vary as to type, capacity, degree of protection provided by truck body, and facilities with which a weapon may be removed.

b. Procedures and Techniques. Fires involving tactical vehicles will vary in origin. Therefore, depending on the degree of seriousness of the fire, the location of the fire in relation to the weapon, and the potential for involvement of the weapon itself, varying techniques will need to be employed in combating the fire-or the situation may dictate evacuation of the area. Under some tactical circumstances extreme measures may be needed which ignore the safety of personnel required to fight the fire. The local commander will determine the action to take under emergency conditions.

(1) In general, the principles and procedures prescribed in paragraphs 6-16 and 6-19 apply to fighting fires involving nuclear weapons in tactical vehicles.

(2) In some cases, the weapon in a tactical vehicle will be attached to a complete missile, with rocket in propulsive or nonpropulsive state. When fire involves the carrying vehicle or launcher, maximum effort will be directed to unloading the vehicle and isolating the complete weapon from

the fire. If this is not possible, the vehicle or launcher will be directed in such a manner that if the motor ignites the rocket will impinge on a solid earth mass such as a mound, hill, or other terrain so as to produce the least possible damage to life and property.

c. ***Missile Fires.*** Guidance for handling fires in complete missiles, carried on tactical vehicles or elsewhere, is given in paragraph **6-22.**

6-21. Weapon Operation Fires

Fires near weapons being processed will vary in magnitude, source, and type.

a. *General.* Electrical fires are most likely to occur during electrical testing or electrical monitoring of the weapon. The fire may occur in a warhead section, in cables leading to the weapon, or in the test equipment. In any situation a sense of urgency and responsibility must prevail and tendency to panic must be overcome by imparting knowledge and skill through training and supervision.

b. ***Procedures and Techniques.*** The following will apply to all weapons not in shipping containers:

(1) Emergency firefighting equipment must be immediately used while the fire is in the incipient state. In every case effort will be made to bring motorized fire department equipment into play before the fire endangers the weapon.

(2) Weapon electrical fires must be dealt with rapidly and with a sense of urgency by knowledgeable and responsible personnel. Electrical fires in a weapons system present a serious condition which, if not imediately brought under control, may gravely affect the safety of personnel, the operation, and the facility or emplacement.

(3) One of the first steps in combating electrical fires will be the removal of power from the weapon or tester, whichever is applicable.

(4) If smoke or flames are emanating from the wiring within the weapon, use CO_2 (carbon dioxide) to extinguish any flames which may be present. The possibility of flames developing is extremely remote; smoke will be expected from overheated components and/or cables usually resulting from a short circuit. Since the smoke from some electrical apparatus may be toxic, necessary measures must be taken to prevent breathing toxic fumes.

6-22. Missile Fires (With or Without Warheads)

When flammable and explosive components for guided missiles and heavy rockets are properly stored by themselves, fire prevention precautions and fire-extinguishing procedures are not complicated. The proper type of extinguishing agent (e.g., water, foam, carbon dioxide, dry chemical) for each combustible component is indicated in missile training manuals or standard texts. However, when a missile is being placed in a "ready" condition, each phase of the assembly, fueling, and warheading places these flammable and explosive components close to each other. This completely changes the method and duration of the fire-extinguishing action, which is further complicated by the possibility that the recommended extinguishing agent for one component may not be correct for all other components involved.

a. ***General.*** The following firefighting guidance is general. The type, size, and design of the missiles in use preclude any attempt to establish firm policy and standards for fire-extinguishing methods and procedures which will be suitable for all types of missiles. Each commander of a missile unit must have a detailed fire plan, and every member of the unit must know what he must do in any given circumstance.

b. *Evacuation.* When a fire occurs, all personnel not essential for extinguishing operations or relocation of other missiles will evacuate the area at once.

c. *Inert Missile.* When an inert missile (i.e., unfueled without warhead, boosters, solid propellant motors, and other dangerous components) is involved in a fire, all types of extinguishing agents and appliances may be used in the area. (*Exception.* Straight water streams should not be directed against burning magnesium, if present, because a violent reaction and splattering of the molten metal will occur. Chemical extinguishers or water, while not effective on burning magnesium itself, may be used to extinguish adjacent fires and assist in reducing the temperature of the magnesium below its ignition point.)

d. Partially Complete Missile. When a partially or completely fueled liquid propellant missile, without warhead or boosters, is involved in a fire, the largest possible volume of water should be directed at the base of the fire; or foam should be used if flammable liquids are the burning fuel. If the fire is on the ground, every effort will be made

to prevent involvement of the missile by flushing the burning fuel away or relocating the missile. All personnel will evacuate the area as soon as any of the following conditions exist:

(1) The surface of the missile starts to melt.

(2) The brilliant white glow of burning magnesium can be seen.

(3) It is readily apparent that complete destruction of the missile cannot be (prevented.

(4) The condition of the missile cannot be determined because of smoke and flames.

e. Complete Missile. Although a risk is assumed in fighting fire involving a fueled and warheaded 'missile, aggressive action should be taken if it appears that the fire may be extinguished or controlled to the extent that the missile will not be enveloped in flames. If the fire is on the ground, large volumes of water or foam should be used to flush any burning liquid away from the missile. If sufficient waterflow is available, a hose stream should be directed on the surface of the missile to cool it; water should not be used for this purpose when the quantity of water available would preclude both cooling and extinguishing at the same time.

6-23. Aircraft Fires

The general procedure for fighting fire in an aircraft is the same whether nuclear weapons are carried or not. Rescue of personnel is primary and will proceed simultaneously with fire control measures as determined by the situation.

a. A rapid survey must be made of the aircraft to determine if the weapon is intact. If at all possible, a visual survey of the weapon within the aircraft will be made.

b. Knowledge of the weapon condition will aid in determining the—

(1) Method of firefighting.

(2) Time allowed to accomplish rescue operations as well as the firefighting.

(3) Cooling techniques to be employed.